Limnological investigations of small water bodies in the Pilis Biosphere Reserve, Hungary

Two forest ponds: Tólaki-láp and Csikóvári-tó

By

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Abstract. The regular limnological investigation of small, lentic, forest water bodies in the Pilis Biosphere Reserve began in 1998. In the course of the present investigations the water chemistry and the Crustacea (Cladocera, Ostracoda, Copepoda) fauna of these waters were studied seasonally. The pH of the surveyed temporary ponds was acidic and moderately acidic, respectively, their conductivity, Ca^{++}, Mg^{++} and HCO_3^- concentrations were low. Nineteen and twenty Crustacea species were recorded in the Tólaki-láp (Tólaki Bog), and Csikóvári-tó (Csikóvári Pond), respectively. From among the investigated water bodies, *Bunops serricaudata* was only found in these ponds.

The Pilis Biosphere Reserve is situated northwest to Budapest in the Pilis and the Szentendre-Visegrádi Mountains. Its area extends over 23,000 hectares. The two middle mountains (max. altitude 757 and 700 m, respectively) are of diverse geological and geographical origin. Pilis is mainly formed from Triassic limestone, the Szentendre-Visegrádi Mountains is volcanic, predominantly consisting of andesite.

The systematic survey of streams and small water bodies in the Pilis Biosphere Reserve started in 1982 (Berczik, 1984). The basic limnological investigations of small water bodies began in 1998. Our study included the determination of the most important water chemistry and environmental parameters and the species composition of the Crustacea (Cladocera, Ostracoda, Copepoda) fauna in twenty-one small waters. The general environmental description, the water chemistry field-work measurements, the presentation of the Crustacea fauna as well as the synthetic evaluation of former publications all were carried out by the author. The results of the water chemical laboratory analyses were derived from M. Gánti-Pap. In this paper we present our data on the adjacent Tólaki-láp and Csikóvári-tó. Former condition of these two ponds had been studied by several authors.

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General description of the study area

The Tólaki-láp and the Csikóvári-tó are temporary forest pools located north to Pomáz in the southern part of the Szentendre-Visegrádi Mountains (Fig. 1). Both are situated in a crater-like depression and fed by precipitation, snowmelt and possibly by seeping confined water, but no spring contributes their water volume.

The Tólaki-láp is located southwest from the Nagy-Csikóvár Peak at 354 m above sea-level. It is surrounded by a closed Querco petraeae-Carpinetum forest. The largest water surface of the pond was recorded in spring, 2000, when it reached 170 × 50 m with a water depth of 130 cm. In years with low precipitation it can completely dry out by the end of July, or beginning of September, but it did not happen in the rainy 1999-2000 period. In the middle of the pond there is a *Salix cinerea* stand, which became larger covering the period of study. In the vegetation period a considerable amount of the water surface is covered by a *Carex* species, *Lemna minor* and *Spirodela polyrrhiza*. In 1999 1–2 dm^3 large *Riccia fluitans* patches developed in the northern part of the pond.

The Csikóvári-tó is 120 m away from Tólaki-láp in the southeast, at 375 m above sea-level in an open oak forest (Quercetum petraeae-cerris). Its size reached 120 × 80 m with a 130 cm water depth during the period of study, but similarly to the Tólaki-láp, it occasionally dries out in dry years.

Human impact is moderate in the area due to its relative isolation.

Previous studies

The Tólaki-láp was first mentioned by Dégen (1922) when describing the Bryophyta flora of Budapest and its surroundings. *Sphagnum cymbifolium* Ehrh. and *Sphagnum cuspidatum* Ehrh. were recorded in the dry bottom of the pond. In spite of this, Dégen concluded that it was not a peat bog as no peat formation occurred there; the presence of *Sphagnum* species was explained by the special ecological conditions of the pond.

Palik (1940) studied the algae flora of Tólaki-láp in 1935-39. Fifty-five algae species were detected including a new Cyanophyta species from the Rivulariacea family, *Gloeotrichia tuzsoni*. Some of the species are acidophilic, characteristic for marshes with low pH, mainly belonging to the order Desmidiales, and to the genera *Cosmarium*, *Staurastrum* and *Closterium*. Besides the earlier mentioned *Sphagnum* species, *Sphagnum acutifolium* Russ & Warrnst was also found in the dry bottom of the pond.

Soós (1940) also reported *Sphagnum cuspidatum* from there. Since then no other *Sphagnum* data has been published from the Tólaki-láp.

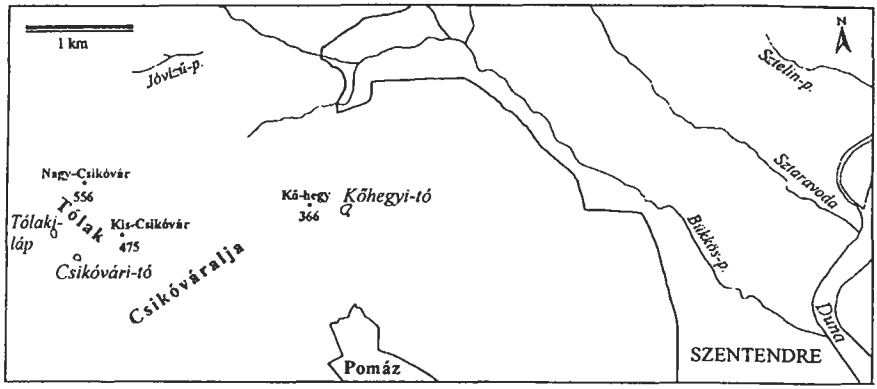

Fig. 1. Location of the sampling sites

According to Megyeri (1970), the special ecological conditions enable *Sphagnum* species to colonise the pond temporarily. In October, 1957 and May, 1958 he studied the microfauna (Testacea, Rotatoria, Cladocera, Ostracoda, Copepoda) and the water chemistry of the pond. Eight Testacea, twenty-two Rotatoria, eight Cladocera, three Ostracoda and seven Copepoda species were then detected. Three of the Testacea species (*Centropyxis aculeata, Lecquereusia spiralis, Euglypha strigosa*) are primarily known from *Sphagnum* bogs. After comparing the microfauna detected in a number of bogs and forest ponds, Megyeri concluded that its composition is basically determined by the chemical characteristics of the water (mainly by pH) and not by the vegetation.

No limnological articles have been published on the Csikóvári-tó, which lies only 120 m away from the Tólaki-láp, except for the thesis of Perendy (1981) dealing with the seasonal changes of its algae flora. He detected seventy species in the pond and concluded that with the exception of some species (*Eunotia lunaris, Schroederia setigera*) the species composition of algae communities changes seasonally. In March and April Dinophyta (*Gymnodinium albulum*), Chlorophyta (*Clamydomonas* spp.) and Chrysophyceae (*Dinobryon sertularia* and *D. sociale, Mallomonas allorgei*), from the end of April to end of May Cryptophyta (*Chroomonas acuta, Chroomonas reflexa, Cryptomonas rostratiformis*), from June Chlorophyta (*Oedogonium indonense, Ulothrix* spp.), Cyanophyta (*Oscillatoria tenuis, Anabaena oscillarioides, Microcystis firma*) and Euglenophyta (*Euglena proxima, Phacus acuminatus*) species dominated the communities. Palik

(1940) and Perendy (1981) only found three common species in the two ponds. Besides the different characteristics of the two water bodies, it could also be caused by the different sampling times and methods. Palik collected several samples between 1935 and 1939, but usually in spring and autumn, while Perendy sampled the Csikóvári-tó several times in a month from March to August. Also, Palik sampled the sediment and aquatic macrophytes for algae as well, while Perendy only had planktonic samples. In spite of all these sampling differences, the considerably higher species number of the acidophil Desmidiales order was characteristic for the Tólaki-láp.

Methods

Water chemistry measurements were carried out in the middle of the open water areas of the ponds, zoological samples were collected from different microhabitats (open water, floating macrophytes, reeds, weed, logs, roots, rocks, etc.). Five seasonal sampling was carried out between 1999 and 2000 (15. 04. 1999, 05. 08. 1999, 28. 10. 1999, 17. 04. 2000 and 03. 07. 2000). Water chemistry parameters were measured with a portable WTW Multiline-P4 multifunctional field equipment. Temperature, pH, conductivity, dissolved oxigen concentration and oxigen saturation were recorded. Qualitative samples were collected from all possible microhabitats with a 70 µm mesh size net to get a general overview of the Cladocera, Ostracoda and Copepoda fauna of the ponds. They were fixed in a 4 % formaldehyde solution on the site. Besides the species composition, the relative abundance of the three Crustacea groups was also estimated by counting 500-600 individuals in the laboratory.

Results and discussion

Water chemistry

Table 1 shows that the water of the Tólaki-láp is acidic with low conductivity and dark humic acids, it is similar to the water of bogs. PH is primarily determined by the amount of precipitation. In 1999-2000, pH increased during the spring and early June rainfall maxima and during possible autumn rains due to the neutrality of the rain water. According to Palik (1940), the pH was also very low (5.5) in September 1939, when there was only little water in the pond due to the lack of rain. In the drier summer months the pH of the water was always acidic (5.42–5.6). Conductivity fluctuated between 55.2 and 121 µS/cm. It decreased in the wet spring and

Table 1. Water surface and water chemistry data of the Tólaki-láp and Csikóvári-tó. (1935-39 and 1980 data were published by Palik (1940) and Perendy (1981), the 1999-2000 data are from the present author)

Characters	Measuring time	Tólaki-láp	Csikóvári-tó
Water surface (m)	1935-39 *	150x70	
	1980 *		70x50
	15. 04. 1999	165x50	120x80
	05. 08. 1999	70x35	55x60
	28. 10. 1999	160x40	120x70
	18. 04. 2000	170x50	130x80
	03. 07. 2000	140x35	100x50
pH	06. 05. 1936	5.6	
	02. 07. 1936	6.0	
	22. 09. 1936	5.5	
	15. 05. 1937	7.5	
	11. 10. 1938	6.8	
	07. 03. 1939	6.8	
	17. 10. 1939	6.2	
	15. 04. 1999	7.18	7.34
	05. 08. 1999	5.49	6.14
	28. 10. 1999	5.62	6.18
	18. 04. 2000	7.32	7.38
	03. 07. 2000	5.42	6.35
Conductivity (μS/cm)	21. 03. 1980		80
	28. 03. 1980		79
	11. 04. 1980		114
	25. 04. 1980		73
	09. 05. 1980		73
	29. 05. 1980		102
	15. 04. 1999	61.5	79
	05. 08. 1999	91	112.2
	28. 10. 1999	63.4	69
	18. 04. 2000	55.2	76.8
	03. 07. 2000	121	143
O_2 concentration (mg/l)	21. 03. 1980		23.82
	28. 03. 1980		11.16
	11. 04. 1980		8.62
	25. 04. 1980		9.27
	09. 05. 1980		11.69
	29. 05. 1980		6.29
	15. 04. 1999	10.18	9.28
	05. 08. 1999	5.20	2.37
	28. 10. 1999	0.36	2.52
	18. 04. 2000	9.05	8.55
	03. 07. 2000	8.95	3.53

* On one occasion measured data

Table 2. Water chemical characterization of the Tólaki-láp and the Csikóvári-tó. (Analyses were made by M. Gánti-Pap, Hungarian Danube Research Station of the Hungarian Academy of Sciences in April, 2000.)

Chemical characters	Tólaki-láp	Csikóvári-tó
Suspended matter (mg/l)	12.0	11.5
Total dissolved solids (mg/l)	14	18
Turbidity (mg/l)	36	30
Alkalinity (W^0)	0.57	0.69
Total hardness (nk^0)	2.15	2.46
Ca hardness (nk^0)	1.22	1.22
Mg hardness (nk^0)	0.93	1.24
HCO_3^- concentration (mg/l)	43.31	46.97
CO_3^{2-} concentration (mg/l)	0	0
Ca^{++} concentration (mg/l)	8.75	8.75
Mg^{++} concentration (mg/l)	4.05	5.4
NO_3^- concentration (mg/l)	0	0
PO_4^{3-} concentration (mg/l)	0.14	0.21
SO_4^{2-} concentration (mg/l)	0	1
Total chemical oxigen demand (mg O_2/l)	28.42	28.23
COD of dissolved matter (mg O_2/l)	25.01	23.72
COD of particuleted matter (mg O_2/l)	3.41	4.51

autumn months while in summer it was higher due to the concentration increase.

The pH of Csikóvári-tó was slightly acidic, the lowest value was 6.14. The conductivity of the water, similarly to the Tólaki-láp, was low though always higher than there, but it never exceeded 150 µS/cm. Conductivity and pH was again primarly governed by precipitation.

On the basis of the three authors' measurements (Palik: 1937-39, Perendy: 1980, Kiss: 1999-2000) there are no considerable differences between the water chemistry of the two pools probably due to the relative small ratio of the human impact.

According to the analysis of the sample from April, 2000, the Ca^{++}, Mg^{++} and HCO_3^- concentration of the two ponds was low due to the great quantity of inflowing water originating from rain and snowmelt (Table 2).

*Table 3. The Cladocera, Ostracoda and Copepoda fauna of the Tólaki-láp and Csikóvári-tó. (++ = abundant, + = intermediate, (+) = rare, * = species found by Megyeri, 1970)*

Species	Tólaki-láp	Csikóvári-tó
CLADOCERA		
Daphnia obtusa Kurz		++
Daphnia curvirostris Eylmann em. Johnson	(+)	+
Daphnia pulex Leydig em. Scourfield		+
Daphnia longispina O. F. Müller	(+)	
Simocephalus exspinosus (Koch)	+	++
Simocephalus vetulus (O. F. Müller)	*	+
Ceriodaphnia reticulata (Jurine)	(+)*	++
Ceriodaphnia laticaudata P. E. Müller	*	++
Ceriodaphnia quadrangula (O. F. Müller)	(+)	
Bunops serricaudata (Daday)	(+)*	(+)
Oxyurella tenuicaudis (Sars)	(+)*	
Alona intermedia Sars	(+)	++
Alona guttata Sars	(+)	
Alonella excisa (Fischer)	(+)*	+
Chydorus sphaericus (O. F. Müller)	++*	++
OSTRACODA		
Candonopsis kingsleii (Brady & Robertson)	(+)	
Pseudocandona compressa (Koch)		(+)
Pseudocandona pratensis (Hartwig)		(+)
Cypria ophtalmica (Jurine)	(+)*	
Cyclocypris ovum (Jurine)	(+)	
Bradleystrandesia fuscata (Jurine)	(+)	
Cypridopsis vidua (O. F. Müller)		++
Cypridopsis elongata (Kaufmann)		(+)
COPEPODA		
Eudiaptomus vulgaris (Schmeil)	(+)*	+
Macrocyclops albidus (Jurine)		+
Eucyclops serrulatus (Fischer)	++	
Paracyclops affinis (Sars)		(+)
Cyclops strenuus strenuus Fischer	++	++
Megacyclops viridis (Jurine)	++*	++

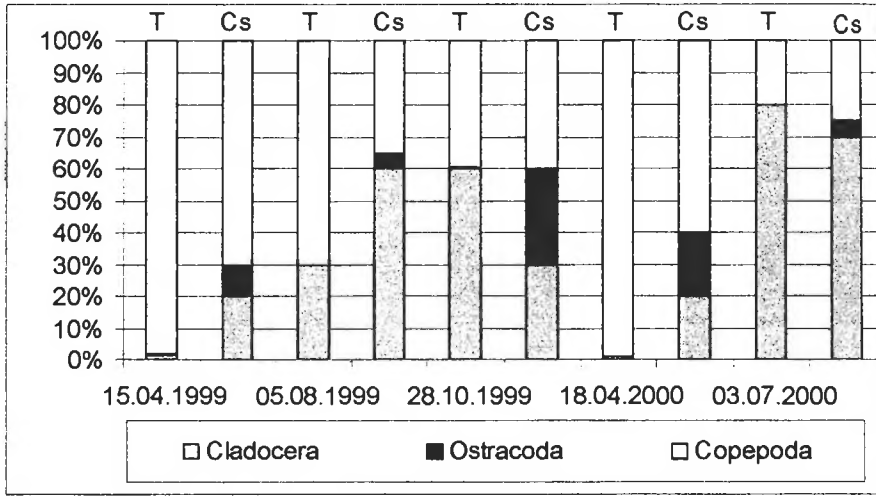

Fig. 2. Relative abundance of the three investigated Crustacea groups in the Tólaki-láp (T) and the Csikóvári-tó (Cs)

Cladocera, Ostracoda and Copepoda fauna

The presence of 29 species (15 Cladocera, 8 Ostracoda, 6 Copepoda) was recorded from the two ponds between April, 1999 and July, 2000 (Table 3).

	Tólaki-láp	Csikóvári-tó	Common
Cladocera	11	11	7
Ostracoda	4	4	0
Copepoda	4	5	3

One of the common species is *Bunops serricaudata*, which was only found in these ponds in the Pilis Mountains. Megyeri (1970) also detected it from the Tólaki-láp. On the other hand, he did not have any *Daphnia* species in his Tólaki-láp species list while all 1999–2000 samples contained that genus even if only with one or two individuals. On the contrary, *Daphnia* individual number was always high in the Csikóvári-tó samples.

With the exception of *Chydorus sphaericus*, Cladocera species were present in low individual number in the Tólaki-láp. It can be explained by the lower pH and the smaller macrophyton cover of the pond. Strikingly different Ostracoda species were found in the two ponds. In general, most ostracods can tolerate wide range of different environmental parameters and they are present in a great variety of water bodies. This phenomenon could probably be caused by the special geographical situation of the ponds. Both are located

in depressions surrounded by steep sides covered by closed oak forests. They are also separated from the other small forest ponds (the nearest Kőhegyi-tó is approximately 2 kms away). In such a situation the effeciency of the most characteristic passive dispersal of ostracods (by wind or on amphibians, bird, etc.) is limited.

The relative abundance of the three Crustacea groups can be seen in Fig. 2. In spring copepods, *Cyclops strenuus strenuus, Megacyclops viridis* were predominantly abundant together with *Eucyclops serrulatus* in the Tólaki-láp. Several individuals of *Eudiaptomus vulgaris* were also found in both ponds. From spring to October there was a relative increase in Cladocera abundance. *Simocephalus exspinosus, Chydorus sphaericus, Ceriodaphnia reticulata, Alonella excisa* were present in both ponds, from April to October, they were abundant in the Csikóvári-tó. With the exception of the spring boom of *Cypridopsis vidua* in the Csikóvári-tó in 2000, Ostracoda species showed a very low individual number in both ponds.

Altogether sixty-four Crustacea (34 Cladocera, 17 Ostracoda, 13 Copepoda) species were recorded in the twenty-one investigated small water bodies of the Pilis Biosphere Reserve including the Tólaki-láp with nineteen and the Csikóvári-tó with twenty Crustacea species. Both are relatively high species numbers in comparison with the fauna of small water bodies (the highest species number was detected in the Kőhegyi-tó, which is situated approximately 2 kms away from the Tólaki-láp and the Csikóvári-tó.). The low pH of the Tólaki-láp did not reduce the species number, but the individual number of the species was always very low. Due to the relative isolation of the ponds, *Bunops serricaudata* was found only in these two water bodies. The composition of the microfauna in the twenty-one investigated small forest ponds was primarly determined by their geographical location, size and habitat diversity and the duration of the water cover.

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REFERENCES

1. BERCZIK, Á. (1984): A Pilis Bioszféra Rezervátum kutatási programja. — Állatt. Közlem., 46: 13-16.

2. DÉGEN, Á. (1922): Bryologiai érdekességek Budapest flórájában. — Magy. Bot. Lap., 21: 26.

3. MEGYERI, J. (1970): Tólak vízi mikrofaunájáról. — Szegedi Tanárképző Főisk. Tud. Közlem., 9: 131-138.

4. PALIK, P. (1940): A hazai tőzeglápok algái. II. A tólaki tőzeges láp Pomáz mellett. — Index Horti Bot. Univ. Budap. 4: 17-42.

5. PERENDY, L. (1981): Algaegyüttesek szezonális változása a Csikóvári-tóban. — Szakdolgozat, ELTE TTK, Budapest, 1-77.

6. SOÓS, Á. (1940): A magyarországi tőzegmoha-lápok fonalférgeiről, II. — Állatt. Közlem., 37: 71-91.